Canada–B.C.
Conservation and Renewable Energy Demonstrations

B.C 18

Energy, Mines and Resources Canada
Conservation and Renewable Energy Branch

Energie, Mines et Ressources Canada
Bureau de la conservation et des énergies renouvelable

Province of British Columbia

Ministry of Energy, Mines and Petroleum Resources
CONSERVATION AND TECHNOLOGY DIVISION

NIMMO BAY
SMALL HYDRO
PROJECT

REPORT

MARCH 1984

Canada/B.C. Conservation and Renewable Energy
Demonstration Agreement

CANADA/BRITISH COLUMBIA CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

The availability of secure and affordable energy supplies is a subject of national concern. It is an accepted fact that our primary energy sources - oil and natural gas - are becoming less accessible and more costly. However, Canada is well-endowed with non-renewable and alternative resources that can provide a bridge into the future.

To this end, the government of British Columbia and Canada have entered into a Conservation and Renewable Energy Demonstration Agreement. The Agreement is dedicated to the development and demonstration of conservation and renewable technologies.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies, which, when widely adopted, will exploit renewable resources, conserve energy and/or use energy more efficiently.
- To develop broad public awareness of the potential of renewable energy and conservation technology.
- To provide opportunities for the commercial application of the technologies within B.C.
- To create employment in new or existing energy-related industries.

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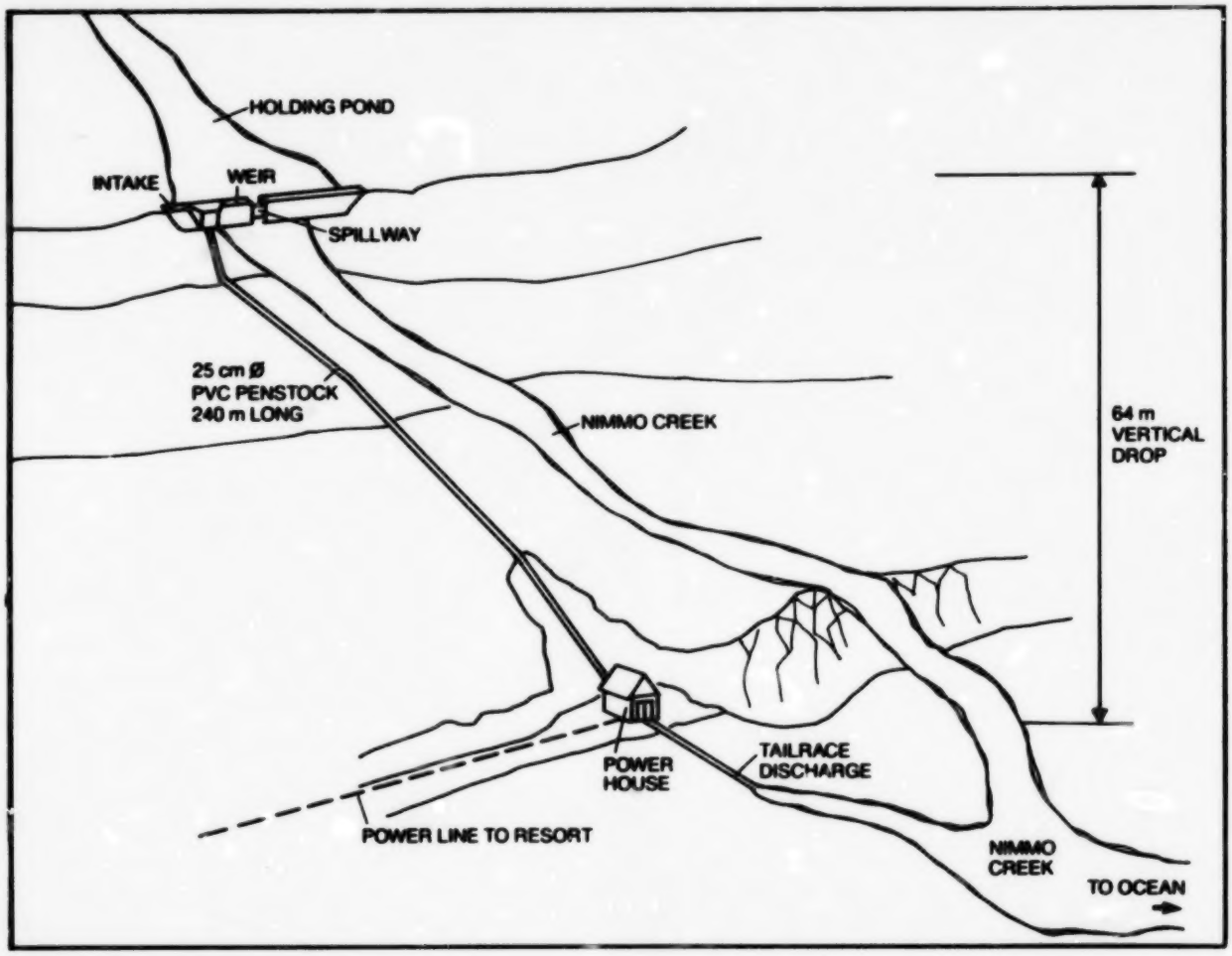
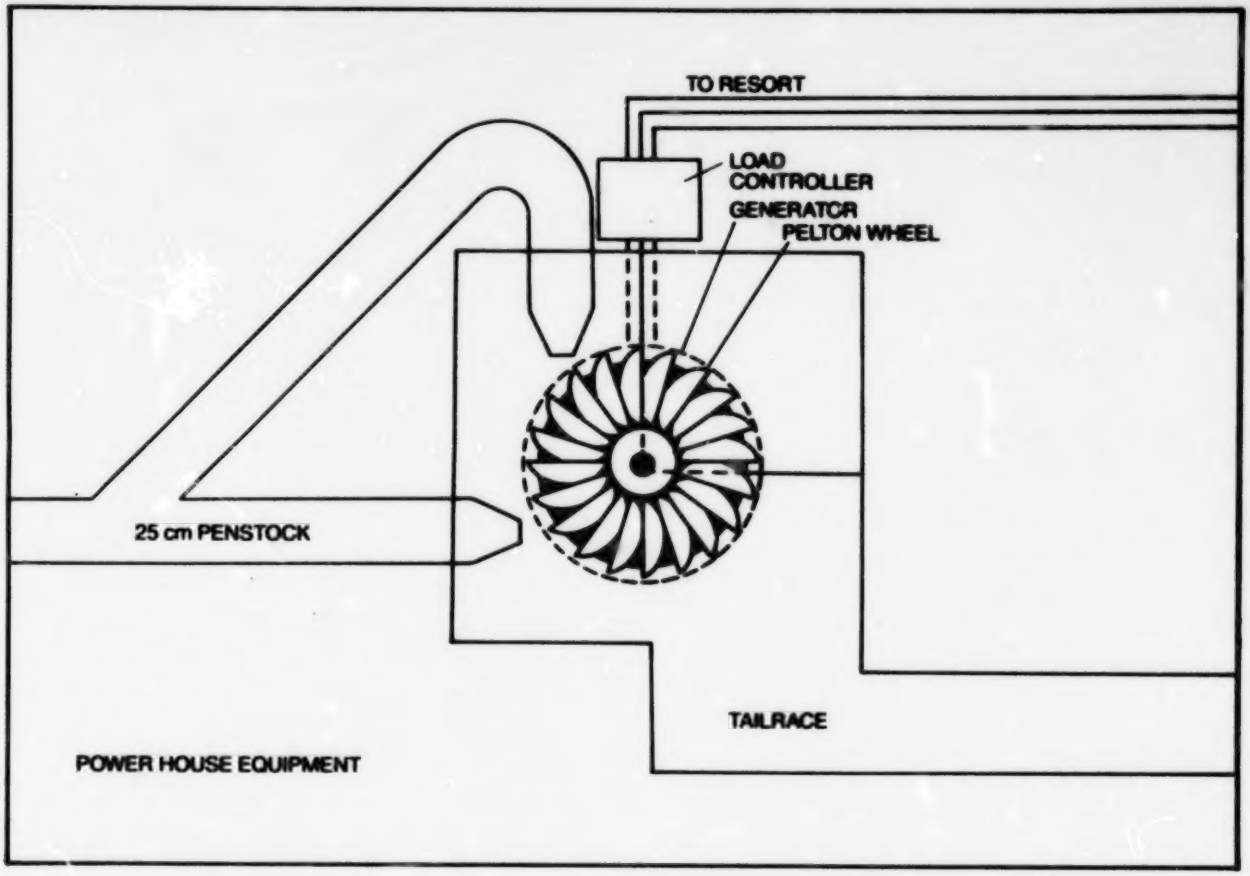
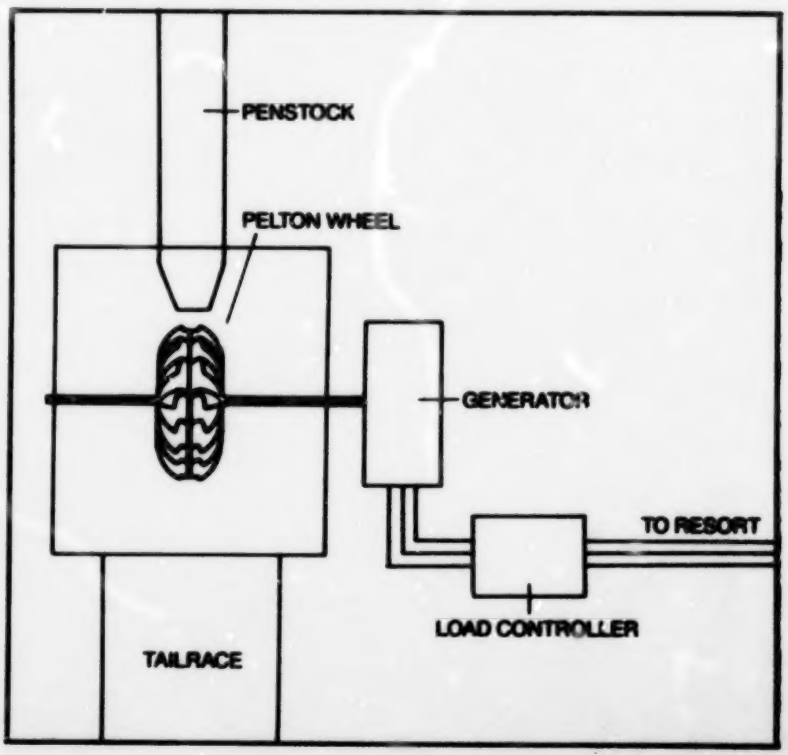
INTRODUCTION

A 35 kilowatt hydroelectric system was installed at Nimmo Bay Resort, a fishing and tourist resort on the north central coast of British Columbia. Nimmo Bay Resort accommodates 8 to 12 guests seasonally (June - September) plus a family of 6 year-round. The purpose of the project was to demonstrate the technical and financial viability of small hydro for a remote commercial operation.

The cost of the project was estimated to be $51,000, which covered the equipment and materials, supplier's installation costs, and information transfer. The capital cost of the installation was approximately $46,000, not including the resort owner's substantial amount of labour. The Canada/B.C. Conservation and Renewable Energy Demonstration Agreement (CREDA) contributed $12,600 and Nimmo Bay Resort provided the remainder of the funds.


HOLDING POND
INTAKE
WEIR
SPILLWAY
25 cm Ø
PVC PENSTOCK
240 m LONG
NIMMO CREEK
64 m
VERTICAL
DROP
POWER
HOUSE
TAILRACE
DISCHARGE
POWER LINE TO RESORT
NIMMO
CREEK
TO OCEAN


TO RESORT
LOAD CONTROLLER
GENERATOR
PELTON WHEEL
25 cm PENSTOCK
TAILRACE
POWER HOUSE EQUIPMENT


PENSTOCK
PELTON WHEEL
GENERATOR
TO RESORT
LOAD CONTROLLER
TAILRACE

TECHNICAL DESCRIPTION

It was determined that 35 kW would be the optimum capacity of the hydro system to serve all the energy needs of the resort, and that Nimmo Creek would handle that capacity. The system was expected to produce 200,000 kWh/year of electricity.

Figure 1 is a schematic layout of the installation. Nimmo Creek provides 64 m of head in a 240 m run. Rock outcroppings and timber from the area were used for anchoring the penstock, weir construction and trestle building. The penstock is 25 cm diameter PVC pipe rated at 100 psi, with the bottom 20 m rated at 125 psi. It was secured with large logs, plus concrete placed at locations of high stress.

Figures 2 and 3 are schematics of the turbine/generator setup. The turbine is a Peltech 975 Pelton wheel, made of stainless steel, 24.8 cm diameter. The water intake manifold contains two nozzles with variable orifices. The demand flow is 0.065 m^3/sec. The turbine is directly coupled to a Lima 40 kW brushless synchronous alternator, 1200 rpm, 120/208 v. 3 phase output. A Thomson and Howe electronic load governor monitors voltage, frequency and current output and also provides for automatic system shutdown in case of system malfunction. The turbine/generator equipment was supplied by Small Hydro-Electrics Canada Ltd., Silverton, B.C. The powerhouse is a 12 ft. x 16 ft. structure with concrete base.

INSTALLATION

The equipment was transported to the site by barge. A helicopter off-loaded and positioned the heavy machinery, and lifted bundles of pipe to predetermined spots along the creek for ease of installation. Power saws were used for cutting timber.

The installation was largely done by the resort owners, with some of the work contracted out. It was found that the amount of work involved in completing the intake and preparing the penstock route had been underestimated. The penstock routing and installation required particular care and effort.

The system was put into service in May 1982. Two days later, the support bearings on the turbine/generator shaft were found to be hot, due to a slight overpacking of grease by the manufacturer. This was promptly rectified. The system was producing 36 kW, using 1 7/8 in. nozzles. The resort was utilizing 18 kW with most energy loads operating. The remaining 18 kW were automatically dumped to the heat sinks. Eventually, the excess power will be used for hot tubs or greenhouses when they are built.

Due to a slight imbalance in the phases, some current was being carried by the neutral wire in the three phase system.

It was noticed that there was no seal for the hole where the shaft runs out of the turbine, and water was being sucked out of the turbine and onto the bearings, forcing out grease. A rubber seal was therefore installed. The bearing closest to the turbine was making a gravelly noise, probably because of the lack of grease which was pushed out by the water. The bearing was greased and the noise stopped.

The butterfly valve regulating the flow of water to the runner was closed a bit to lower power production to 24 kW, since the full 36 kW was not needed.

PERFORMANCE

In late June 1982 the system was shut down for inspection and it was found that step #1 of the load shedding mechanism was not functioning due to broken heaters. The damage must have occurred when the screen that was tack welded over the immersion box for the heat sinks had come loose in May 1982 and was ripped off by the force of the water.

In late June, frequent power surging started to occur. In mid-July the water flow decreased so the system was dropped down to one nozzle. The system still supplied 18 kW of power which was more than enough. From this time on there was significant power surging. Trying to compensate by turning loads off and on at the breakers did not help. The supplier of the load controller was called in and he found that four heaters had broken when the screen ripped off, and one triac and the voltage regulator had burnt out.

After replacement of six heaters, the triacs and the voltage regulator, serious power surging still occurred. At this time the water supply was decreasing so the 1 7/8 in. nozzle was replaced by a 1 in. nozzle. This supplied only about 4 kW. The water supply was adequate for a 1 5/16 in. nozzle but that size was not yet on hand. By mid-August, rain permitted use of the 1 7/8 in. nozzle again. The system was running 24 hours per day. A few days later the nozzle was changed again because of lower water. At this time a 1 5/16 in. nozzle was used. There was still a lot of power surging. In late August the 1 in. nozzle was substituted because of lower water. The system was found to be very versatile with the ease of changing nozzles to suit the available water supply.

Wtih heavy rain in early September, the 1 7/8 in. nozzle was used. Under flood conditions, sand and sticks from the stream piled over the intake filter of the penstock and shut down power for a day until it could be cleared.

No surging was occurring now and the system was running smoothly. The water level dropped by mid-September and the nozzle was switched to the 1 5/16 in. and then the 1 in. The water level was low in late September but power was still available for the freezers, fridges, lights and hot water tank. At this point the rainy season started in earnest.

At low power times it is necessary to juggle loads because not all appliances can be used at the same time.

Full power was available for all of October and into November. Leaves periodically clogged the filter of the penstock; this was cleared by closing the butterfly valve, stopping suction through the penstock, and the leaves floated off the screening.

By mid-November, lack of rain and melting snow necessitated reducing the nozzle to 1 5/16 in. and then to 1 in. By the end of the month the system was again using the 1 7/8 in. nozzle.

In December a new electronic module and triac were installed on the electronic load controller to stop power surging.

The system worked well in December and January, but a problem occurred in February 1983. The situation that occurred shortly after startup, of grease being forced out of the turbine shaft bearing because of omission of the seal, eventually resulted in wear of the shaft, probably due to fine grains of sand. The pillow block bearings and the 2 3/16 in. steel shaft had to be replaced.

Otherwise, the system ran well in February and continued to operate well. It supplied all of the resort's power needs (18 kW) except for 10 days of low water during the summer of 1983. The system has eliminated the need for oil for most of the year and is considered a success.

Servicing by Small Hydro-Electrics was disappointing. They were often slow to respond to requests for service or information. This is to some extent an inherent problem in a business where customers are all in remote locations. However, the supplier has not yet installed the fail-safe shutdown mechanism, long after the original commissioning of the hydro system.

ECONOMICS

The capital cost of the system was $46,000, broken down as follows:

Machinery	$21,000
Penstock	7,000
Powerhouse, @ $18/sq.ft. for 12' x 16' structure with concrete base	3,500
Supplier's labour (2 1/2 men, 4 weeks each)	9,000
Supplier's room and board at site	2,500
Transport (including barge and tug for equipment delivery and helicopter for lifting at site)	3,000

This does not include the substantial amount of time spent by the resort operators in installing the penstock and other tasks.

The estimated first year saving in diesel fuel was $11,200 and, in addition, estimated saving in diesel system maintenance was $1,350 for total first year saving of $12,550.

The system has proven capable of displacing most, but not all, of the diesel requirements.

The CREDA contribution to the project was $12,600, of which $5,000 was for monitoring and information transfer.

CONCLUSIONS

The 35 kW Nimmo Bay small hydro installation was a successful one, displacing most of the diesel oil requirements of the resort. The estimated first year savings were $12,550, compared to the capital expenditure of $46,000, not including the substantial amount of time spent by the resort owners in installing the penstock and other tasks. This time expenditure had been greatly underestimated by the owners.

Operation of the system requires participation by the owners, in changing nozzles in reaction to changing water levels and because of periodic minor breakdowns or maintenance. In addition, the remoteness of the site has resulted in relatively slow servicing by the supplier.